CHAPTER 8. TRAFFIC OPENINGS

8-1.01 Introduction

The specifications include special requirements which apply only to falsework which is over or adjacent to traffic. These requirements are included to ensure higher standards of design and construction at locations where public safety is involved.

8-1.02 Horizontal and Vertical Clearances

The minimum width and height of each opening to be provided through the falsework will be shown in the special provisions.

When checking horizontal clearances, keep in mind that the "width" of a vehicular opening is the distance between the temporary railings. The clear distance between falsework posts will be considerably greater than the width shown in the special provisions.

For a vehicular opening, no portion of the falsework may encroach into the "clearance zone" established by a vertical plane located three inches behind the back edge of the temporary K-rail at its base and extending upward to a horizontal plane at the top of the rail, and a second vertical plane located nine inches behind the first plane and extending from the horizontal plane at the top of the rail upward to the falsework stringer. See Figure 8-l.

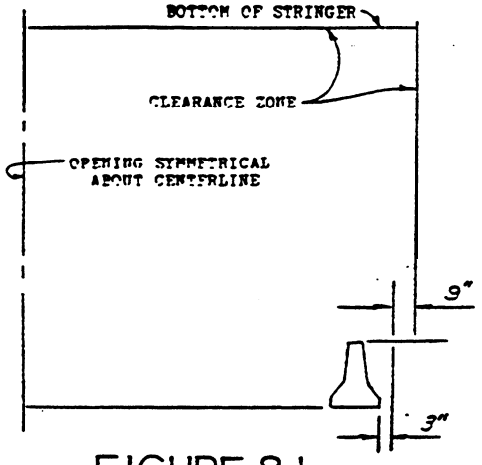

FIGURE 8-1

When checking vertical clearances, keep in mind that deflection of the falsework stringers under the dead load of the concrete will reduce the theoretical clearance, and this must be considered in the falsework design.

8-1.03 Requirements at Traffic Openings

The special requirements discussed in this section apply to falsework openings for both highway and railroad traffic. Additional requirements which apply only to railroad openings are discussed in the following section.

Each falsework post must be mechanically connected to its supporting footing or otherwise laterally restrained so as to withstand a 2000-pound force applied at the base of the post. When administering this specification, the term "supporting footing" will be interpreted as meaning the element of the falsework system that is set on the ground.

The 2000-pound force will be applied at the base of each post regardless of its size, spacing or, loading; however, it will be assumed as acting on only one post at a time. Lateral restraint must be effective parallel to and also away from the roadway or railroad track. For a bent in a highway median, restraint must be effective in all four directions.

Many contractors prefer to adjust falsework to grade by wedging or jacking at the bottom of a falsework bent, rather than at the top. In such designs, two or more posts will be supported by a bottom cap of sill beam which, in turn, will be supported by wedges or jacks set on the falsework footing. See Figure 8-2.

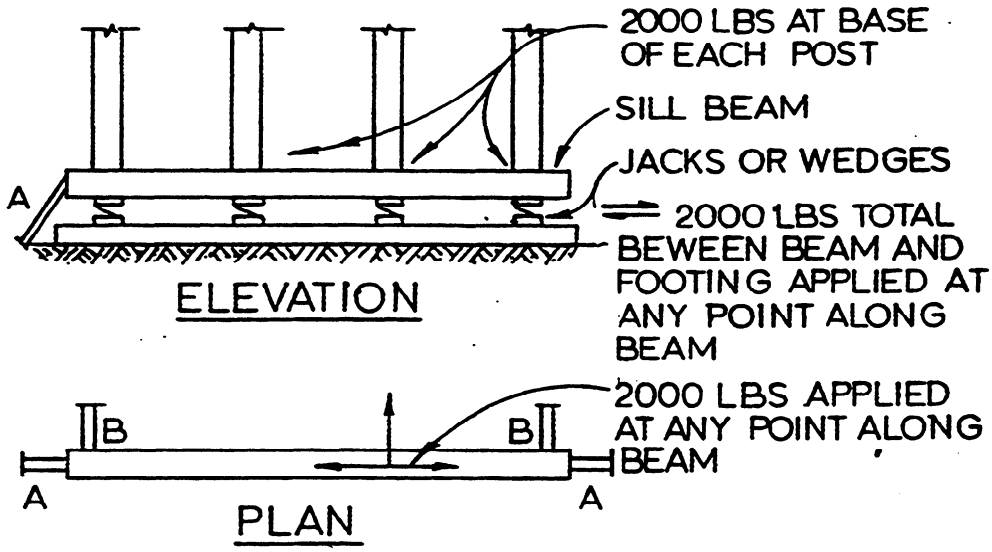

FIGURE 8-2

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When any type of "double-sill" is used at the bottom of a falsework bent adjacent to traffic, each post anchor must be designed to resist the 2000-pound force. Note, however, that the design force does not accumulate along the sill beam, so the connection between the beam and the falsework footing need resist only 2000 pounds total, regardless of the number of posts supported. Note also that a single point of restraint will not provide adequate resistance in the transverse direction (2000-pound force applied perpendicular to the beam) unless the connection is capable of resisting moment as well as shear. As a practical expedient, then, the sill beam must be restrained at both ends, and both connections must be designed to resist (transfer) 2000 pounds.

As an alternative means of providing lateral restraint, the 2000-pound force may be carried from the sill beam directly to the ground in the manner shown at A and B in Figure 8-2.

Each falsework post must be mechanically connected at its top to the falsework cap, and the connection must-be designed to resist a lOOO-pound force acting in any horizontal direction.

When double caps are used at the top of a falsework bent, they must be connected or restrained in some manner to prevent differential movement in both the longitudinal and transverse directions. The total force to be applied to each pair of caps is 1000 pounds, regardless of the number of posts in the falsework bent. Note, however, that the lOOO-pound force is actually a couple since it acts simutaneously in planes at the top of the lower cap and the bottom of the upper cap. Therefore, when analyzing the connection between double caps, it is necessary to consider moment as we11 as shear to ensure the stability of the double-cap system.

For falsework over traffic, the specifications require certain stringers to be mechanically connected to the falsework cap. The connection must be capable of resisting a force in any direction, including uplift, of not less than 500 pounds. These connections must be installed and functional before traffic is permitted to pass under the falsework span.

Details showing the connection between stringer and cap, cap and post, and post and footing, must be shown on the falsework drawings. Such details will be reviewed for contract compliance in the same manner as all other details of the falsework design, except that a load duration factor of 2.0 (for impact loading) may be used to determine the allowable value of nails and bolts used in the connection. However, other connection components must be so designed that the specified maximum allowable stresses in bending, shear and bearing are not exceeded.

The specifications require bolted connections when timber members are used to brace falsework bents adjacent to traffic. This requirement applies to bracing in the longitudinal as well as the transverse direction. Also, when timber members are used as longitudinal bracing, the brace must be bolted at both ends. It is not acceptable practice to use a bolt at one end of a brace and nails or lag screws at the other end.

All components of the falsework system which contribute to horizontal stability and resistance to impact, except for bolts in bracing, must be installed at the time each element of the falsework is erected. Therefore, friction cannot be considered as contributing to the strength of the connection, at either the top OF the bottom, because frictional resistance is not developed until a load is applied.

The provision that bolts need not be installed when the falsework is erected is included in the specifications to facilitate adjusting of the falsework to grade. However, if the contractor elects to use nails in lieu of bolts as a temporary expedient, the nailed connection must be shown on the falsework drawings, and the connection must be designed to resist either the theoretical wind load or two percent of the total dead load to be supported while the connection is in use, whichever results in the larger force.

When nails are used as a temporary connection to facilitate grade adjustment, they should be replaced by bolts as soon as feasible, and in any case prior to placing concrete.

The vertical load used for the design of posts and towers which support falsework over traffic openings must be increased to at least 150 percent of the load calculated in the usual manner. This "modified design load" is used to determine the stresses in vertical load-carrying components in the falsework bent, but it will not be applied to caps or footings, nor will it be used to check soil pressure.

In the case of towers, the modified design load will be applied to all tower legs when the end reaction of the member over traffic is distributed through a cap system to all legs, as shown in falsework Tower A in Figure 8-3. If the entire end reaction is carried by the tower legs adjacent to traffic, then the modified design load is applied only to those legs. See Tower B.

If the load on falsework adjacent to or over a traffic opening will be increased by load-transfer due to prestressing, the

design vertical load for posts and towers will be either the actual (unmodified) load plus the additional load due to prestressing or 150 percent of the actual load, whichever is larger.

The "modified design load" requirement is included in the specifications because both theory and experience have demonstrated that the downward force exerted by the bridge superstructure does in fact increase after the deck concrete is placed. The increased force is the result of deck shrinkage during the curing period; consequently, it will be larger at falsework bents located near the center of the bridge span than at bents near the abutments or columns. Furthermore, the increased force is of greater concern in the case of cast-in-place prestressed structures (which have little load-carrying capacity until tensioned) than in conventionally-reinforced concrete structures.*

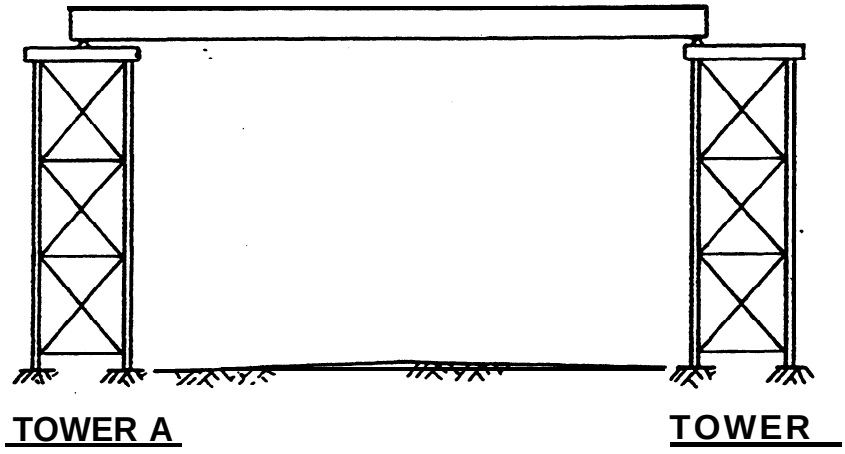

FIGURE 8-3

* As a point of interest, field research conducted some years ago revealed that -- depending on falsework configuration, type of structure and construction sequence -- the maximum load imposed on the falsework varied from as little as 110 percent to as much as 200 percent of the load measured approximately 24 hours after deck concrete placement. Maximum load was reached in four to seven days. The 150 percent figure in the specifications is a compromise which recognizes that some increase will occur in virtually all instances.

While the falsework system as a whole will remain relatively stable as the downward force increases, individual components may not. In any falsework design, vertical members are the least stable elements in the system and therefore the most vulnerable; consequently, the specification directly addresses posts and towers. This is not to say, however, that other members will not be affected, since the increased load must be carried from the bridge soffit to the ground through all components of the falsework bent. The engineer should be aware of this and look for points of potential instability. As an example, the method of grade adjustment should be scrutinized, particularly where a double-cap system is used. Wedges will remain stable under the added load; screw jacks may not.

Stresses calculated by applying the modified design load may not exceed the allowable stresses listed in the specifications.

When pipe-frame of tubular steel components are used as falsework shoring adjacent to a traffic opening, either as individual posts or as legs in a tower bent, the specified minimum section modulus for steel columns will apply to the post or tower leg, but not to the screw jack extension.

Finally, the specifications require the installation. of temporary bracing during erection and removal of any falsework whose height exceeds its clear distance to either the edge of any sidewalk or shoulder of any roadway which is open to the public, or to a point 10 feet from the centerline of any railroad track. When administering this specification, keep in mind that while wind loads are to be considered in the design, the basic requirement is that the bracing must be adequate to "withstand all loads imposed". Under the specifications, then, the contractor must determine the design load, which may not be less than the specified wind load for the height of falsework under consideration.

Details showing the temporary bracing, or other means of support provided to meet the intent of the specifications, must be shown on the falsework drawings. Such details are a part of the falsework design and must comply with all contract requirements even though the bracing or other means of support may be only "temporary" restraining devices.

8-1.04 Additional Requirements at Railroad Openings

The design of falsework which is over or adjacent to railroad traffic must comply with all of the special requirements for falsework at traffic openings and, in addition, must meat other requirements which are unique to railroad openings.

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The principal design requirement is that bracing for falsework bents located within 20 feet of the track centerline must be designed to resist the assumed horizontal load or 5000 pounds, whichever is greater. This requirement applies to both transverse and Longitudinal bracing. In the specification context, the term "bent" means t-he overall length of the falsework bent regardless of the number of posts used. As a point of information, the 5000-pound load will govern the design only in the case of relatively narrow structures where the bent consists of about five, or fewer, falsework posts.

When the 5000-pound load governs the design, the duration of load factor in the connector analysis is determined as follows:

If in the absence of the 5000-pound design load requirement, the design would have been governed by the wind load, a duration-of-load factor of 1.33 may be used.

In all other cases the factor will be 1.25, unless the anticipated duration of load dictates the use of a lower factor.

The design of falsework at railroad openings is subject to review and approval by the railroad company involved. To expedite approval, falsework drawings submitted for railroad company review should conform to the following procedural requirements:

All design and construction details must be shown. If a reference is made to a standard plan or to a detail shown on a previously submitted drawing for another structure in the contract, such plans or drawings must accompany the submittal to the railroad.

When submitting only that portion of the falsework which is over or adjacent to the railroad, details of the adjacent falsework spans must be shown, as these spans will affect the design of the bents at the railroad opening.

Design features or details for snore than one structure should not be shown on the same drawing.

The drawings should include a sketch showing the location of the temporary minimum horizontal and vertical clearance to the falsework.

Soffit and deck overhang forming details should be included.

For timber construction, all connections must be made with bolts. The use of coil rods or threaded rods in place of bolts of the same diameter is not permitted at railroad openings.

When timber stringers are used, the railroad will require solid end blocking, regardless of the height-to-width ratio of the timber stringers.

The drawings must include a note stating that collision posts will be provided as per the contract special provisions, but post details need not be shown.

To ensure that the Office of Structure Construction is fully informed of all matters relating to falsework over a railroad facility, correspondence to and discussions with the railroad company must be handled by the Falsework Review Section in the Sacramento office. Neither bridge field personnel nor contractor personnel are authorized to communicate directly with the railroad.

Restricted temporary horizontal and vertical clearances require Public Utilities Commission approval. The bridge engineer should make certain PUC Approval has been granted before approving the falsework drawings.